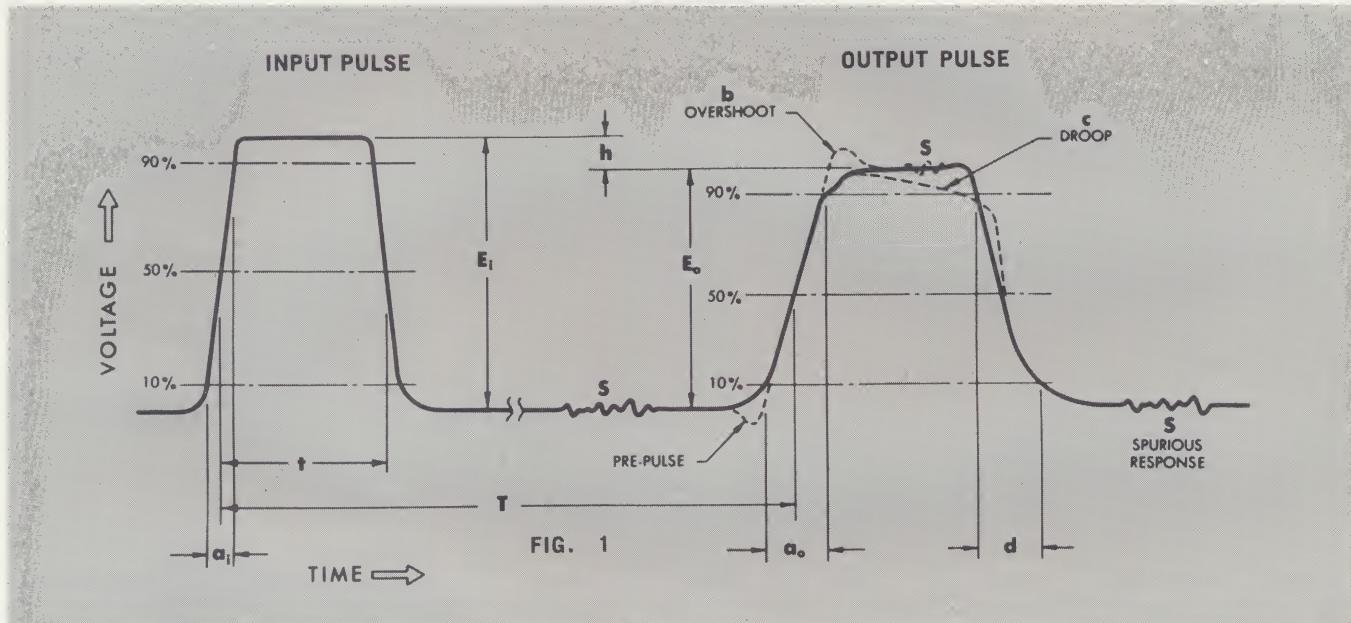


Delay Lines

Terminology

In order to evaluate and specify your delay line requirements, it is helpful to be familiar with the terminology. The terms most often used to describe and specify delay line characteristics are given below. Where appropriate they're shown on Fig. 1. Dashed lines show common variations in output waveshape.



a RISE TIME...

a_1 Input pulse rise time
 a_0 Output pulse rise time
 a_n Network pulse rise time

$$a_n = \sqrt{(a_0)^2 - (a_1)^2} \text{ approx.}$$

b OVERRSHOOT...

A continuation of the leading edge of the pulse

c DROOP...

A sloping of the top of the pulse

d FALL TIME...

$$h \text{ ATTENUATION (in db)} = 20 \log \frac{E_i}{E_o}$$

S SPURIOUS RESPONSE—Distortion—Ripple...

Three common terms used to define any irregularities in the signal output of the delay line due to various causes. This may be expressed as db below E_o

t PULSE WIDTH...

Usually measured at 50% amplitude points.

T DELAY TIME... The pulse delay is usually measured from the 50% amplitude point of the leading edge of the input pulse to the 50% amplitude point of the leading edge of the output pulse.

CHARACTERISTIC IMPEDANCE, Z_0 ... Characteristic impedance of the delay line is the impedance presented to an input pulse applied to the delay line. A delay line is usually terminated in a resistance equal to the characteristic impedance.

DELAY/RISE TIME RATIO, T/a_n ... The ratio of total delay to the delay line rise time is one measure of the quality of the delay line.

BANDWIDTH... Those frequencies which are passed at a useful amplitude (attenuated 3 db or less, for example). This is related to rise time approximately by

$$\text{bandwidth} \times \text{rise time} = .4$$

TEMPERATURE COEFFICIENT... Usually expressed as a percent change in delay per degree Centigrade.

PHASE SHIFT... Delay lines may be used as phase shifting devices. A delay line will shift the phase of a sine wave an amount in degrees equal to $360 \times \text{delay time} \times \text{frequency of sine wave}$. $\theta = 360 \times T \times f$.



CONTROL ELECTRONICS COMPANY, INC.

153 Florida Street, Farmingdale, L.I., N.Y. 11735 • (516) 694-0125

High Frequency Delay Lines

Delay Lines for operation at frequencies up to 500 megacycles are now being developed and produced to meet special requirements. Control Electronics offers to fill your high frequency delay line requirements. We are able to fill all the environmental and tolerance specifications that are presently being met with our lumped constant delay lines at lower frequencies. These high frequency delay lines are available in fixed and variable types or can be tapped at various delay points. They are made to meet applicable military specifications.

Characteristics of delay lines, developed by Control Electronics, for high frequency application are shown in the following table.



Model V215
125 Mc/s bandwidth

Characteristic	Model Number			
	V215	F258	F264	F272
Time Delay	0 to 50 n sec	10 n sec	50 n sec	200 n sec
Rise Time	—	—	10 n sec	16 n sec
Bandwidth	125 Mc/s	500 Mc/s	50 Mc/s	30 Mc/s
Impedance	50 ohms	50 ohms	100 ohms	120 ohms
Spurious	< 5%	< 3%	< 3%	< 3%
Attenuation (Pulse)	< 5%	< 1%	< 5%	< 10%
Terminals	BNC/Type N	BNC	WIRE LEADS	WIRE LEADS
Thermal Stability	50 PPM/°C	50 PPM/°C	50 PPM/°C	50 PPM/°C

Model V215 was specifically developed for use by the Radio Astronomy Station of the Harvard College Observatory in its Star Tracking experiments. It is designed for continuous motor driven application and is constructed with a rugged, printed circuit, commutator type switch having rhodium plated segments and a silver alloy wiper arm. Resolution is one part in 120.



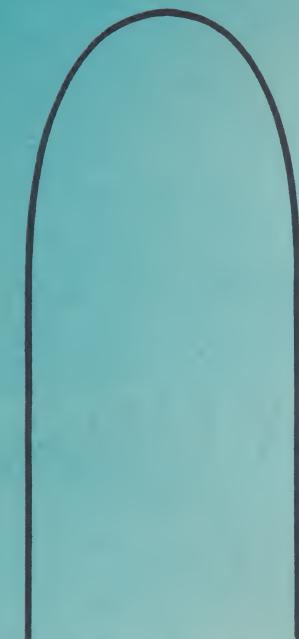
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HF-6401

military & commercial

DELAY LINES



MAGNETOSTRICTIVE ■ LUMPED CONSTANT ■ DISTRIBUTED CONSTANT



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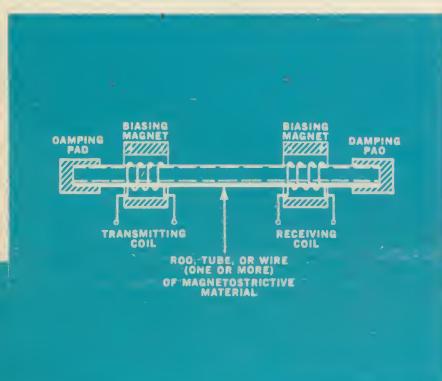
INTERNATIONAL SALES: EMEC Inc., 160 Terminal Drive, Plainview, N.Y. 11803
CABLE: Electronic, Plainview NEWYORKSTATE

C

To keep pace with a constantly improving technology, CEC offers a complete series of **tested** and **proven** Delay Lines to meet every requirement. At CEC, many years of experience go into supplying consistently high performance at lowest possible cost. Delay Lines shown here the typical, and are merely indicative of the wide range offered by CEC . . . most deliverable from off-the-shelf stocks. Custom-designed units with varying size, weight, volume, terminal or mounting configuration, delay to rise time, bandwidth, VSWR, etc., are also available at low production prices. For simplified ordering, use the handy CEC Engineering-Specification Card.

MAGNETOSTRICTIVE DELAY LINES

In magnetostriuctive delay, an electrical signal is converted into a sonic wave which travels through a treated nickel alloy wire and is re-converted to an electrical signal at the "far" end of the wire. The wire length is an accurate measure of the delay time. CEC Magnetostriuctive Delay Lines feature substantially long delay capability (to 10,000 microseconds in one unit) and low temperature coefficients (1.0 ppm/ $^{\circ}$ C). Write for specification sheet MS-6402.



MAGNETOSTRICTIVE DELAY SCHEMATIC

Conversion to a sonic wave, then reconversion to an electrical signal, attenuates the signal as much as 70 db. Most electronic circuits cannot afford to suffer a 70 db loss in signal strength. However, CEC offers Magnetostriuctive Delay Lines either without or with unity gain circuits which restore signal strength to its original level. When several delay lines are stacked in series for increased delays, each delay line should include unity gain output circuits to restore signal to its original level at the output of each line.



FIXED DELAY MAGNETOSTRICTIVE LINE

Delays to 5,000 microseconds available in 6" x 6" x 1" case; to 10,000 microseconds in 8" x 8" x 1". Circuitry for unity gain included.



SHORT DELAY — VARIABLE MAGLINES

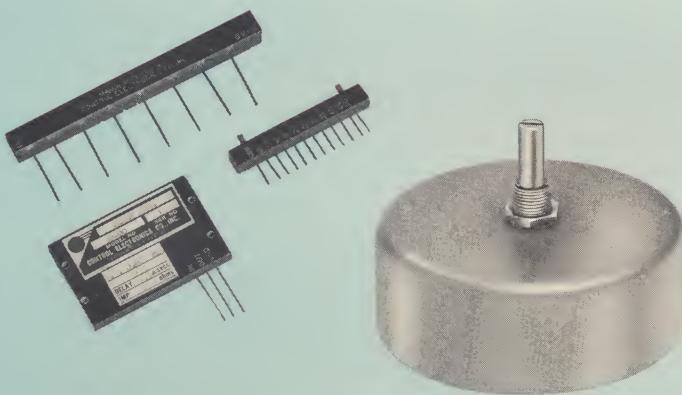
Used as a variable or fixed delay line. Infinite resolution. Unique clutch arrangement at ends of stops. Ideal for PC boards.

LONG DELAY — VARIABLE MAGLINE, KNOB ADJUSTABLE

Up to 10,000 microseconds delay available in single units. Case dimension: 4" OD x 4 1/2" long or 9" OD x 3 1/2" long.

LUMPED CONSTANT DELAY LINES

Lumped Constant Delay Lines offer microsecond delay times in extremely compact packages. Delay is achieved through the usual LC circuits which are matched and designed to offer minimum attenuation of signal . . . for use without additional amplification. Units are hermetically sealed with temperature coefficients of approximately 45 ppm/ $^{\circ}$ C. Write for Specification Sheet LC-6404.



COMPACT, FIXED DELAY LINE FOR PC BOARD APPLICATION— FULLY ENCAPSULATED

Many models with delays to 10 microseconds available . . . attenuation is only 1.0 db. All connections from one face for plugging into PC Board and dip soldering.

MINIATURE ROTARY VARIABLE DELAY LINE

Only 3" diam. x 1" high unit provides a variable delay line with delays to 3 microseconds . . . resolution 1:120. Sixty position selector switch can be supplied with motor drive.



STEP VARIABLE DELAY LINE

Delays to 12 microseconds available in 60 steps or less. Can be supplied with motor drive. Dimensions: 4 1/4" x 4 1/4" x 1 1/4".

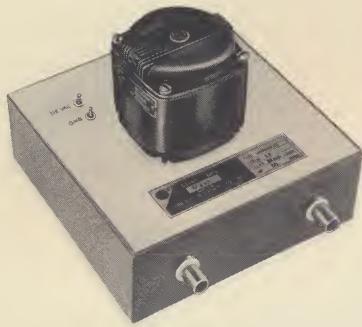


MINIATURE VARIABLE DELAY LINES—TO 2 MICROSECONDS

Can operate at 500 vdc. Screwdriver delay adjustment shown at right end of unit. Dimensions: 4 3/4" x 1/2" x 1 1/2".

HIGH FREQUENCY DELAY LINES

Delays with 500 Mc/s bandwidths available. Write for Specification Sheet HF-6401.



MOTORIZED VARIABLE DELAY

With extraordinarily high bandwidth.

AUDIO DELAY LINES

Delays to 100 milliseconds in one unit with excellent phase, attenuation, impedance and other specifications. Write for Specification Sheet AD-6402.



CASCADED DELAY CABINET

Weighs only 200 lbs. Provides delay of 100 milliseconds (four 25 ms units) with taps at every 1 ms . . . within 1%. Bandwidth: 400 cps.

DISTRIBUTED CONSTANT DELAY LINES

Distributed Constant Delay Lines employ a ground plane or metallic ribbon as the capacitance of an LC network . . . and are generally less expensive than Lumped Constant Delay Lines. Units are hermetically sealed with temperature coefficients of approximately 50 ppm/°C. Write for Specification Sheet DC-6401.



SQUARE UNIT

For easy mounting to PC board. All connector pins extend from one surface.



FIXED DELAY LINE

Compact and accurate with delays to 4 microseconds in this section. Using several alternating "lines" running back and forth, any delay can be achieved.

Distributed by:

Postage
Will be Paid
by
Addressee

No
Postage Stamp
Necessary
If Mailed in the
United States

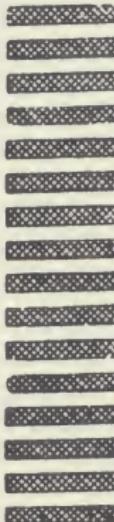
BUSINESS REPLY MAIL

First Class Permit No. 297, Farmingdale, New York

C

CONTROL ELECTRONICS COMPANY, INC.

153 Florida Street, Farmingdale, L.I., N.Y. 11735



SEND ADDITIONAL LITERATURE ON
THE FOLLOWING TYPE DELAY LINE

	fixed	tapped	variable
Lumped Constant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Distributed "	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Magnetostrictive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> All the above			

SEND A COPY OF "DELAY LINE
TERMINOLOGY"

HAVE REPRESENTATIVE CALL ON ME.

RECOMMEND A DELAY LINE TO MEET THE FOLLOWING
REQUIREMENTS AND QUOTE ON QUANTITIES OF _____

Delay _____ usec + _____ usec. With Taps at _____, _____, _____ usec
Input Pulse: Width _____ usec. Rise Time _____ usec
Input Current: _____ milliamps. Output Voltage: _____ millivolts
Output Pulse: Rise Time _____ usec or Frequency
Response _____ or Digital Bit Rate _____
Impedance: Input _____ ohms. Output _____ ohms
Attenuation: _____ db max. Spurious: _____ % max
Thermal Coefficient: _____ PPM/°C. Temp. Range _____ °C to _____ °C
If Variable: Range _____ usec to _____ usec. Resolution: _____
Environmental Specs: _____

Maximum Size: _____

Other Requirements: _____

Mr. _____
Title or Position _____
Company _____
Address _____
Street _____
City _____ State _____ ZIP _____
Phone _____ Ext _____

Distributed Constant Delay Lines

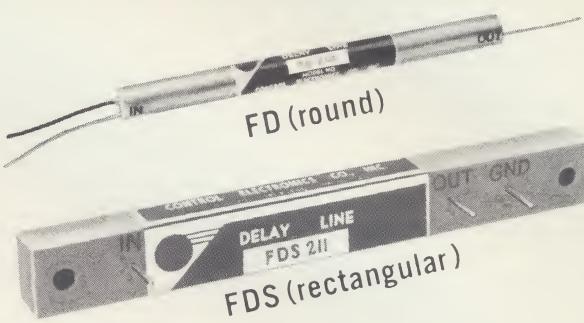
GENERAL SPECIFICATIONS

for Standard and Custom Units

Construction	Encapsulated in Epoxy resin Moisture and fungus resistant Made to MIL specifications
Operating Temperature	-55°C to +125°C
Thermal Stability	.50 ppm/°C
Attenuation	.08 db per μ sec. approximate
Test Voltage	500 Vdc

OPTIONAL FEATURES:

All Distributed Constant Delay Lines are offered in a choice of:
Round or Rectangular cross-section sticks
"FD" catalog designation is for Round $1\frac{1}{32}$ " O.D. stick
"FDS" catalog designation is for Rectangular $\frac{3}{8}$ " x $\frac{1}{2}$ " stick
Pigtail or pin leads
Stud or insert mounting (FDS line only)
Tap points to your requirements



- LOWEST COST—RELIABLE PERFORMANCE
- SMALL SIZE, LIGHT WEIGHT
- IMPEDANCES: 200 TO 4000Ω
- BANDWIDTHS TO 20 Mc/s
- LINEAR PHASE SHIFT

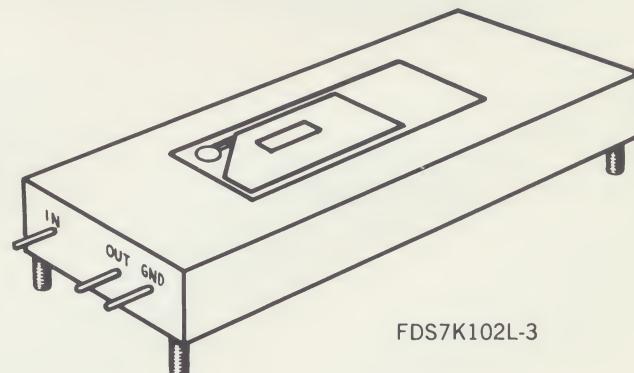
Delay μ sec $\pm 5\%$	Rise Time Less than μ sec*	CHARACTERISTIC IMPEDANCE $\Omega \pm 10\%$						
		300 (D)	500 (F)	1000 (K)	1500 (L)	2000 (M)	3000 (N)	4000 (Q)
.1	.014	FD7D101B	FD7F101B	FD7K101B	FD7L101B	FD7M101C	FD7N101C	FD7Q101C
.2	.029	FD7D201C	FD7F201C	FD7K201C	FD7L201C	FD7M201D	FD7N201D	FD7Q201D
.3	.043	FD7D301D	FD7F301D	FD7K301D	FD7L301D	FD7M301E	FD7N301E	FD7Q301E
.4	.057	FD7D401E	FD7F401E	FD7K401E	FD7L401E	FD7M401F	FD7N401F	FD7Q401F
.5	.071	FD7D501F	FD7F501F	FD7K501F	FD7L501F	FD7M501G	FD7N501G	FD7Q501G
.6	.085	FD7D601G	FD7F601G	FD7K601G	FD7L601G	FD7M601H	FD7N601H	FD7Q601H
.7	.10	FD7D701H	FD7F701H	FD7K701H	FD7L701H	FD7M701J	FD7N701J	FD7Q701J
.8	.115	FD7D801J	FD7F801J	FD7K801J	FD7L801J	FD7M801K	FD7N801K	FD7Q801K
.9	.130	FD7D901K	FD7F901K	FD7K901K	FD7L901K	FD7M901L	FD7N901L	FD7Q901L
1.0	.14	FD7D102L	FD7F102L	FD7K102L	FD7L102L	FD7M102M	FD76102M	FD7Q102M
1.5	.21	FD7D152M	FD7F152M	FD7K152M	FD7L152M	FD7M152N	FD7N152N	FD7Q152N
2	.40	FD5D202J	FD5F202J	FD5K202J	FD5L202J	FD5M202K	FD5N202M	FD5Q152Q
4	.80	FD5D402N	FD5F402N	FD5K402N	FD5L402N	FD5M402P		

Longer delays than shown are provided by enclosing several sticks in one case.

e.g. 3 μ sec, using FDS7K102L-3, dimensions will be $\frac{3}{8}$ " x $1\frac{1}{2}$ " x 6"

10 μ sec, using FDS7K102L-10, dimensions will be $\frac{3}{4}$ " x $2\frac{1}{2}$ " x 6"

NOTE: number of sticks is designated by the numeral following the dash at the end of the catalog #. Thus FDS7K102L-3 designates 3 sticks.



FDS7K102L-3



CONTROL ELECTRONICS COMPANY, INC.

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Variable Delay Lines

- **CONTINUOUS ROTATION**, or with mechanical stop
- **SUITABLE FOR MOTOR DRIVE**—we will supply units with motor drive to meet your specification



4 1/4" x 4 1/4" x 1 1/4"

Model V203

TYPICAL CHARACTERISTICS*

Model	Time Delay	Steps	Impedance (Ohms)	Rise Time	Attenuation	Max. Input (Volts)
V203	0.5 μsec	4.2 nsec	580	35 nsec	.5 db	500
V226	0-120 nsec	1 nsec	100	15 nsec	.5 db	500
V227	0-0.3 μsec	2.5 nsec	100	25 nsec	1 db	500
V228	0-0.3 μsec	2.5 nsec	5000	40 nsec	2 db	500
V229	0-1.2 μsec	10 nsec	2500	150 nsec	1 db	500
V230	0-3.0 μsec	25 nsec	1000	250 nsec	1 db	500
V231	0-12 μsec	100 nsec	250	750 nsec	6 db	300
V710	0-6 μsec	50 nsec	1000	300 nsec	2 db	500
V743	0-1 μsec	0.833 nsec	75	15 nsec	.5 db	500
V745	0-5 μsec	42 nsec	100	250 nsec	2 db	500

*Characteristics can be varied to suit your needs.

Control Electronics' miniature series of rotary variable delay lines are 1" high and only 3" in dia. These lines are ruggedly constructed and hermetically sealed to provide high reliability and a long service life. The delay variation is selected by a 60 position shorting type rotary switch. This shorting feature provides an intermediate delay of $\frac{1}{60}$ step so that the resolution is one part in 120. This switch, designed by Control Electronics, can be motor driven at speeds in excess of 10 rpm, and has been life tested for over 1,000 hours of continuous use.



Model V397

Model	Time Delay	Rise Time	Impedance (Ohms)	Attenuation
V364	0 to .1 μsec	.01 μsec	50	.5 db
V365	0 to .2 μsec	.01 μsec	50	1 db
V390	0 to 3.0 μsec	.25 μsec	750	2 db
V397	0 to 1.2 μsec	.10 μsec	1000	1 db
V440	0 to 1.5 μsec	.15 μsec	500	2 db



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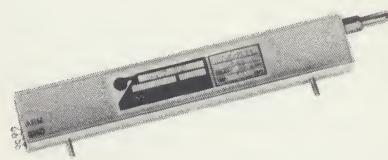
Variable Delay Lines

- **RESOLUTION:** Better than .001 μ sec.
- Can be terminated externally or internally.
- All models are hermetically sealed.

- Can be operated above ground potential.
- **DC WORKING VOLTS:** 500 volts max.
- High impedance tap (variable)

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VR 900	.10 μ sec	.025 μ sec	100
VR 901	.20 μ sec	.030 μ sec	200
VR 902	.70 μ sec	.080 μ sec	500
VR 903	.95 μ sec	.090 μ sec	500
VR 904	.50 μ sec	.055 μ sec	750
VR 905	.40 μ sec	.040 μ sec	1000
VR 906	.25 μ sec	.030 μ sec	1300
VR 907	.20 μ sec	.030 μ sec	1500

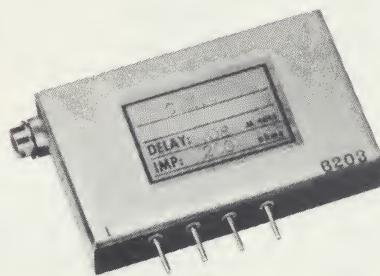
*Rise time at maximum delay setting.



- **ATTENUATION:** Less than 1.5 db.
- **OPERATION:** Continuously variable shaft rotation of 10 turns from zero to maximum delay
- **OUTSIDE DIMENSIONS:** $7\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{4}$
- Locking device optional at no extra charge

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VS 950	0.75 μ sec	0.25 μ sec	390
VS 951	0.62 μ sec	0.206 μ sec	470
VS 952	0.50 μ sec	0.16 μ sec	560
VS 953	0.37 μ sec	0.125 μ sec	680
VS 954	0.25 μ sec	0.085 μ sec	1000
VS 955	0.125 μ sec	0.042 μ sec	1000
VS 956	0.062 μ sec	0.021 μ sec	1500
VS 957	0.125 μ sec	0.042 μ sec	1800
VS 958	0.080 μ sec	0.027 μ sec	200

*Rise time at maximum delay setting.



- **ATTENUATION:** 0.5 db max.
- **OPERATION:** Continuously variable shaft rotation of $2\frac{1}{2}$ turns from zero to maximum delay.
- **OUTSIDE DIMENSIONS:** $2\frac{3}{8} \times \frac{1}{2} \times 1\frac{1}{2}$

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VL 1000	1.50 μ sec	.30 μ sec	390
VL 1001	1.25 μ sec	.25 μ sec	470
VL 1002	1.0 μ sec	.20 μ sec	560
VL 1003	0.75 μ sec	.15 μ sec	680
VL 1004	0.50 μ sec	.10 μ sec	1000
VL 1005	0.25 μ sec	.04 μ sec	1000
VL 1006	0.125 μ sec	.03 μ sec	1500
VL 1007	0.25 μ sec	.06 μ sec	1800

*Rise time at maximum delay setting.



- **ATTENUATION:** Less than 1.0 db.
- **OPERATION:** Continuously variable shaft rotation of 5 turns from zero to maximum delay.
- **OUTSIDE DIMENSIONS:** $4\frac{3}{4} \times \frac{1}{2} \times 1\frac{1}{2}$



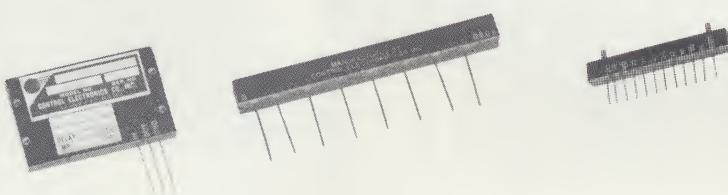
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LC-6401

Miniature Tapped Delay Lines

- **DELAY TOLERANCE:** $\pm 3\%$ or $\pm 0.01 \mu\text{sec}$
- **TAPS:** 10, equally spaced
- **THERMAL STABILITY:** 45 ppm/ $^{\circ}\text{C}$
- **TEST VOLTAGE:** 500 Vdc
- **WORKING VOLTAGE:** 300 Vdc
- **PULSE VOLTAGE:** 50 volts peak
- **TEMPERATURE RANGE:** -50°C to $+125^{\circ}\text{C}$
- **LEADS:** #22 AWG tinned copper or brass



LC-6402

Delay $\mu\text{sec.}$	Maximum Output Rise Time $\mu\text{sec.}$	Bandwidth Mc/s	Impedance Range (Ohms)	Dimensions (inches)
0.05	.008	64	50-100	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.1	.014	32	50-200	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.2	.028	16	100-400	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.3	.043	12	50-500	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.4	.057	9	60-600	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.5	.072	6.4	80-800	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.6	.085	5.3	100-1000	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.7	.1	4.6	100-1500	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.8	.115	4	100-2000	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
0.9	.129	3.5	100-2000	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
1	.145	3.2	200-2000	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
2	.286	1.6	250-1500	$1\frac{1}{2} \times 1\frac{1}{2} \times 3$
3	.428	1.06	300-2000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
4	.57	0.82	500-1000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
5	.715	0.63	400-1000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
6	.85	0.53	500-1000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
7	.95	0.455	600-1000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
8	1.05	0.40	1000	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
9	1.25	0.35	750	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$
10	1.4	0.32	500	$1\frac{1}{2} \times 3\frac{1}{4} \times 3$

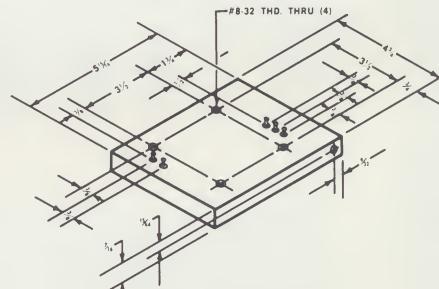
Compact Magline

Model	Delay	Adj. From Center Delay	Max. Pulse Rep. Rate	Attenuation
FM 401 Commercial 402 Military	50 to 1200 μsec	$\pm 4 \mu\text{sec}$	1 Mc/s	55-65 db

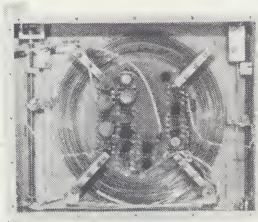
TYPICAL CHARACTERISTICS:

1. Input impedance 50Ω to $2000\Omega^*$
2. Output termination 50Ω to $5K\Omega^*$
3. Signal to noise ratio 20:1
4. Change in delay with temp. $1 \times 10^{-5} \frac{\mu\text{sec}}{\mu\text{sec}} / ^{\circ}\text{C}$ nominal
 $1 \times 10^{-5} \frac{\mu\text{sec}}{\mu\text{sec}} / ^{\circ}\text{C}$ on order

*Specify when ordering



Magline Memory Systems



Model	Delay	PRR	S/N	Input Level
FMS 4013	5000 μsec	250 Kc/s	26 db	3-15 V
FMS 4037	4400 μsec	650 Kc/s	32 db	3-15 V
FMS 4047	250 μsec	340 Kc/s	20 db	5 V
FMS 4066	3500 μsec	850 Kc/s	35 db	6 V



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MS-6402

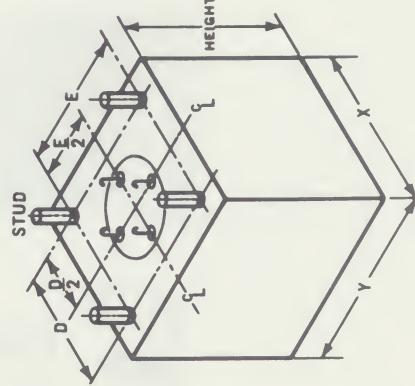
Lumped Constant Delay Lines

STANDARD UNITS

BUILT TO MIL SPECIFICATIONS

Zo in Ω		50(A)		180(C)		500(F)		1,000(K)		1,500(L)		2000(M)		3000(N)		5000(R)		7500(R)		10000(T)	
Time	Delay	μs	Rise	Time	μs	Code	Code	Code	Code	Code	Code	Code	Code								
.25	.015	F17A251AE	F17C251AE	F17C251AE	F17F251AE	F10C251AE	F5C251AA	F10F251AE	F5F251AA	F17F501CE	F10F501AE	F5F501AA	F10M501CC	F5M501AE	F5M251AE	F5N251AE	F5N501AE	F5N501AE	F5N501AE	F5T152AE	
	.025	F10A251AE	F10C251AA	F10A251AA	F17C501AE	F10C501AE	F5C501AA	F10F501AE	F5F501AA	F10M501CE	F10F501AE	F5F501AA	F10M501CC	F5M501AE	F5M251AE	F5N251AE	F5N501AE	F5N501AE	F5N501AE	F5T152AE	
.50	.03	F17A301AE	F17C301AE	F17C301AE	F17F301AE	F10C301AE	F5C301AA	F10F301AE	F5F301AA	F10M301CE	F10F301AE	F5F301AA	F10M301CC	F5M301AE	F5M251AE	F5N251AE	F5N501AE	F5N501AE	F5N501AE	F5T152AE	
	.05	F10A301AE	F10C301AA	F10A301AA	F17C301CE	F10C301CE	F5C301AA	F10F301CE	F5F301AA	F10M301CE	F10F301AE	F5F301AA	F10M301CC	F5M301AE	F5M251AE	F5N251AE	F5N501AE	F5N501AE	F5N501AE	F5T152AE	
.10	.010	F33A102CE	F33C102CE	F33C102CE	F33F102CE	F20C102CE	F10C102CE	F10F102CE	F5F102CE	F10M102CE	F10F102CE	F5F102CE	F10M102CC	F5M102AE	F5L102CE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE	
.10	.05	F20A102CC	F10C102CE	F10A102CE	F10C102CE	F10C102CE	F5C102AE	F10F102CE	F5F102AE	F10M102CE	F10F102CE	F5F102AE	F10M102CC	F5M102AE	F5L102CE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE	
.20	.10	F5A102AE	F5C102AE	F5A102AE	F30C152CE	F20C152CE	F10C152CE	F20F152CE	F10F152CE	F30M152DE	F20M152DE	F10M152CE	F20M152DE	F10M152CC	F5M152AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
.1.5	.05	F30A152CE	F30C152CE	F30C152CE	F30F152CE	F20C152CE	F10C152CE	F20F152CE	F10F152CE	F30M152DE	F20M152DE	F10M152CE	F20M152DE	F10M152CC	F5M152AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
.15	.075	F20A152CC	F20C152CE	F10A152CE	F20C152CE	F10C152CE	F5C152CE	F20F152CE	F10F152CE	F20M152DE	F20M152DE	F10M152CE	F20M152DE	F10M152CC	F5M152AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
.30	.15	F5A152AE	F5C152AE	F5A152AE	F33C502EE	F20C502CE	F10C502CE	F20F502CE	F10F502CE	F33M502GD	F20M502GD	F10M502CE	F20M502DE	F10M502CC	F5M502AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
.50	.15	F33A502EF	F33C502EE	F33C502EE	F33F502GD	F20C502CE	F10C502CE	F20F502CE	F10F502CE	F33M502GD	F20M502GD	F10M502CE	F20M502DE	F10M502CC	F5M502AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
.50	.25	F20A502CE	F20C502CE	F10A502CE	F20C502CE	F10C502CE	F5C502CE	F20F502CE	F10F502CE	F33M502GD	F20M502GD	F10M502CE	F20M502DE	F10M502CC	F5M502AE	F5L102CC	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
1.00	.10	F5A502CE	F5C502CE	F5A502CE	F33C103GD	F20C103GD	F10C103GD	F20F103GD	F10F103GD	F33M103ID	F20M103ID	F10M103DE	F20M103DE	F10M103CC	F5M103AE	F5L103DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
10.0	.3	F20A103EE	F20C103GD	F20C103GD	F33C103GD	F20C103GD	F10C103GD	F20F103GD	F10F103GD	F33M103ID	F20M103ID	F10M103DE	F20M103DE	F10M103CC	F5M103AE	F5L103DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
1.0	.5	F33A103EE	F20A103EE	F10A103EE	F20C103GD	F10C103GD	F5C103CE	F20F103GD	F10F103GD	F33M103ID	F20M103ID	F10M103DE	F20M103DE	F10M103CC	F5M103AE	F5L103DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
2.0	.20	F5A103CE	F5C103CE	F5A103CE	F33C203JC	F33C203JC	F33C203JC	F33F203GD	F20C203GD	F33L203GD	F33L203GD	F20L203DE	F20P203DE	F10N203DE	F5N203AE	F5L203DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
2.0	.6	F33A203GE	F33C203JC	F10A203GE	F33C203JC	F10C203GD	F5C203CE	F20F203DE	F10F203DE	F33M203GD	F33M203GD	F20L203DE	F20P203DE	F10N203DE	F5N203AE	F5L203DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
2.0	.40	F10A203EF	F10C203DE	F5A203CE	F5C203CE	F5C203CE	F5F203CE	F10F203DE	F5F203CE	F33M203GD	F33M203GD	F20L203DE	F20P203DE	F10N203DE	F5N203AE	F5L203DE	F5L501AE	F5L501AE	F5L501AE	F5L501AE	F5T152AE
50.0	.1.5	F33A503JF	F33C503JD	F33C503JD	F33F503GD	F20C503JD	F10C503JD	F20F503GD	F10F503GD	F33M503GD	F20M503GD	F10M503DE	F20M503DE	F10M503CC	F5M503AE	F5L503DE	F5L503AE	F5L503AE	F5L503AE	F5T152AE	
	2.5	F20A503JC	F20C503JD	F10A503GE	F20C503JD	F10C503DE	F5C503CE	F20F503GD	F10F503GD	F33M503GD	F20M503GD	F10M503DE	F20M503DE	F10M503CC	F5M503AE	F5L503DE	F5L503AE	F5L503AE	F5L503AE	F5T152AE	
	5.0	F5A503CE	F5C503CE	F5A503CE	F33C104JF	F33C104JF	F33C104JF	F33F104GD	F10F104GD	F33L104GF	F33L104GF	F20L104DE	F20P104DE	F10N104DE	F5N104AE	F5L104DE	F5L503AE	F5L503AE	F5L503AE	F5L503AE	F5T152AE
	10.0	F33A104JF	F33C104JF	F10A104GE	F10C104DE	F10C104DE	F5C104CE	F20F104GD	F10F104GD	F33L104GF	F33L104GF	F20L104DE	F20P104DE	F10N104DE	F5N104AE	F5L104DE	F5L503AE	F5L503AE	F5L503AE	F5L503AE	F5T152AE
200	.60	F33A204JL	F33C204JF	F10C204GD	F10C204GD	F10C204GD	F5C204CE	F20F204GD	F10F204GD	F33L204IC	F33L204IC	F20L204EE	F20P204EE	F10N204EE	F5N204AE	F5L204DE	F5L504AE	F5L504AE	F5L504AE	F5L504AE	F5T204JD
500	.150	F33A504JL	F33C504JL	F10C504GD	F10C504GD	F10C504GD	F5C504CE	F20F504GD	F10F504GD	F33L504IF	F33L504IF	F20L504EE	F20P504EE	F10N504EE	F5N504JF	F5L504DE	F5L504AE	F5L504AE	F5L504AE	F5L504AE	F5T204JD

STAPLED AS REQUIRED



BASE AND MOUNTING CODE

Letter Size	Mounting Dimensions				Stud Size
	Letter Size	X	Y	D	E
A 1½"	1½"	1½"	1½"	1½"	6-32 x ¾"
B 2"	2½"				
C 2½"					
D 3"	1½"	1½"	1½"	1½"	6-32 x ¾"
E 3½"	2½"	2½"	1 1½"	1 1½"	6-32 x ¾"
F 4"	2 3/4	2 3/8	2 1/8	1 3/4	6-32 x ¾"
G 4½"					
H 5"	3½"	2 5/8	2 15/16	1 5/8	8-32 x ¾"
J 5½"	3 15/16	3 3/8	3	2 1/16	10-32 x ½"
K 6"					
L 6½"	5 1/2	4 1/2	3 3/4	3	1/4-20 x 5/8"
M 7"					

Last letters of the catalog number indicate size.
Example: E10E501AF (here A indicates Base, F indicates Height)

DELAY TOLERANCE:	$\pm 3\%$ $+.01$ μ sec.
IMPEDANCE TOLERANCE:	$\pm 10\%$
ATTENUATION:	Less than .2 times the delay to rise time ratio
THERMAL STABILITY:	50 parts/million /°C
OPERATING TEMPERATURE RANGE:	-55°C to $+125^{\circ}\text{C}$
SPURIOUS SIGNALS:	Less than 10%

Magnetostriuctive Delay Lines For Memory Systems

SERIES FMS 5000 All solid-state circuitry, self contained for application in memory systems or cascaded systems for extra-long delays (or information capacity). Units operate in a non-return-to-zero (NRZ) mode. Amplifier restores output signal level to same strength as input.

SPECIFICATIONS (FMS 5000 Series):

Delay (per unit): 50 to 4200 microseconds
Adjustment: ± 2 usec (trimmer adjustment with exclusive slip-clutch, non-jam feature).
Repetition Rate: 3.0 Mc, maximum.
Temperature Range: 0 - 50°C.
Input Power: ± 12 vdc at 75 ma; alternate ± 25 vdc at 50 ma.
Input Logic: $\pm 6 \pm 2$ vdc (logic "1"), 0 $\pm 1/2$ vdc (logic "0"); alternate, 0 and -6 vdc.
Output Logic: 10 ma at same logic as input (True and False output).
Connector: Terminals or PC connector flying leads or as specified.
Accuracy: Permits cascading without signal deterioration.
Case: Self-enclosed.
Mounting: Clear-through holes.
Thickness: Series FMS 5000, 1"; Series FMS 4000, $3/4$ ".

For complete, packaged memory systems including associated gates . . . CONSULT FACTORY

SERIES FMS 4000 Provides same magnetostriuctive delay circuit as FMS 5000, but without the signal-restoring amplifier. Signal-to-noise ratio is 20:1, typical. Attenuation: 55 to 70 db.



PART NUMBER TABLE

P/N	DELAY	MAX. PULSE REP. RATE*	SIZE	PPM/°C
FMS 5051 to FMS 5101	50 usec to 100 usec	3.0 Mc	5" x 6"	5
FMS 5101 to FMS 5102	100 usec to 1000 usec	2.6 Mc	5" x 6"	1
FMS 5102 to FMS 5252	1000 usec to 2500 usec	2.3 Mc	6" x 7"	1
FMS 5252 to FMS 5422	2500 usec to 4200 usec	2.0 Mc	8" x 9"	1

*NOTE: FMS 4000 Series (without associated circuitry) permits up to 15% improvement in Max. Pulse Rep. Rate.

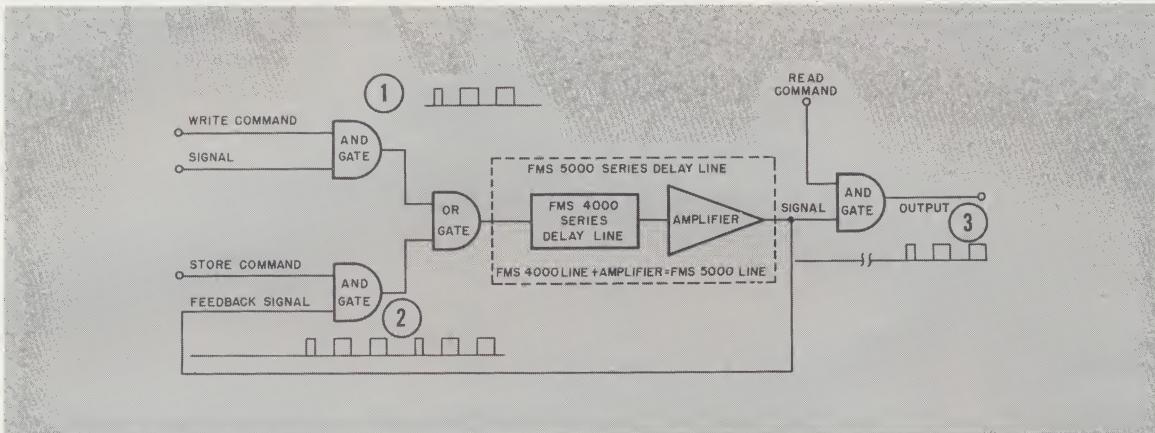


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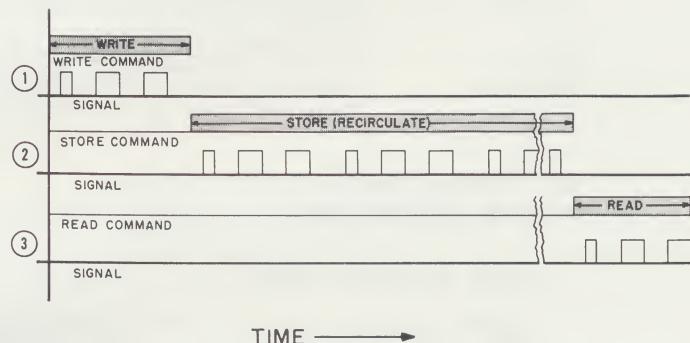
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Memory System Application

BLOCK DIAGRAM #1 — MEMORY SYSTEM, SIMPLIFIED

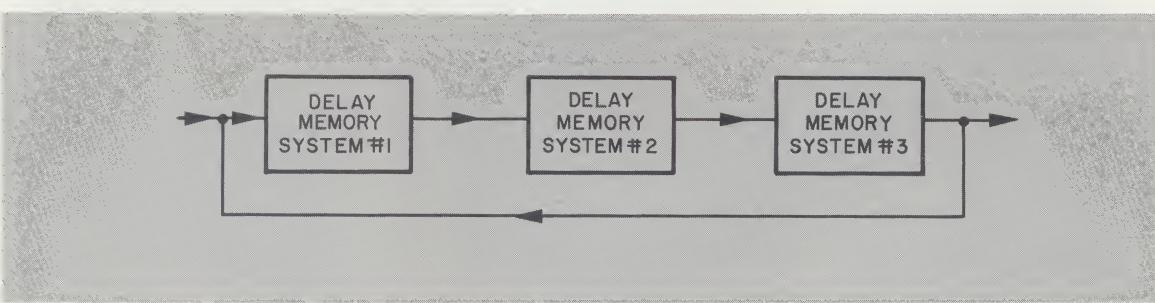


Memory systems are used to store information for intervals of time prior to reading (using) the information. For example, the output data from a computer may be delivered to a recorder too close behind the delivery of previous data. A delay line can be used to hold (store) the data until the recorder input is unloaded. See Block Diagram #1. Information may be stored, read or new data may be written in at any time.



For extremely long delays or large bit storage capacity, information is best preserved by a cascaded memory system. In this application, several Series FMS 5000 delay line memory systems are connected in series, as shown in Block Diagram #2. FMS 5000 Series outputs are compatible with (can be fed directly into) the input of another FMS Series line. Buffer stages are not required.

BLOCK DIAGRAM #2 — CASCADED MEMORY SYSTEM



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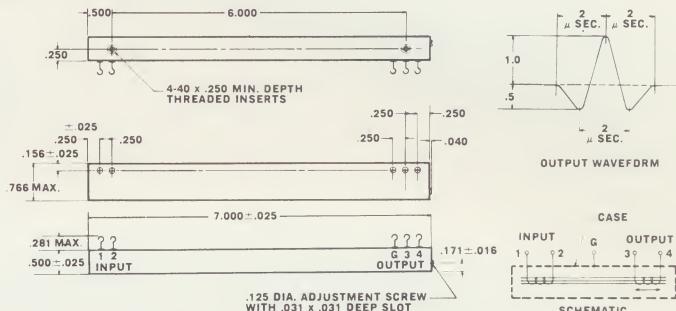
Variable Maglines

- **TIME DELAY:** 2-22 μ sec
- **OPTIMUM INPUT PULSE WIDTH:** 1.0 μ sec \pm 2 μ sec
- **MAXIMUM PRF:** 500 Kc/s
- **MAXIMUM AVERAGE POWER INPUT:** 0.1 watt
- **IMPEDANCE RANGE FOR INPUT OR OUTPUT:** 50 to 4000 ohms

Line is stocked in 700 ohm input and output impedance and has the following specific characteristics:

**MAXIMUM PULSE VOLTAGE TO REACH
SATURATION LEVEL: 40 V peak**

MAXIMUM OUTPUT SIGNAL LEVEL: 40 mV peak



L x .5" W x .760

complies with MIL-STD-202-A



Model VM1030



Model VM1090

MODEL VM 1030	SPECIFICATIONS	MODEL VM 1090
3 to 500 μ sec	Delay Range	3 to 4000 μ sec
50 ohms to 4K ohms	Impedance Range	50 ohms to 4K ohms
3 μ sec	Min. Pulse Spacing	3 μ sec
12 mv	Output when driven with 15 V Pk. - 1 μ sec pulse	6 mv
10	Turns for full delay	28
4" O.D. x 4.5" L	Size	9" O.D. x 3 5/8" L
2 lb.	Weight	5 lb.



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MS-6401